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Attorney's Docket No.: 07977-108002 / US3190D1

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Transl

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Koyama, et al.
Serial No.: 09/757,778
Filed : January 9, 2001
Title : ACTIVE MATRIX LIQUID CRYSTAL DISPLAY AND METHOD OF FABRICATING SAME

Art Unit : 2871
Examiner : Tai Duong
Confirmation NO. 8473

Commissioner for Patents
Washington, D.C. 20231

TRANSMITTAL OF ENGLISH TRANSLATION

Referencing the amendment filed on December 19, 2002, and at the request of the Examiner, a full English translation of Japanese document JP-07-349229, filed December 19, 1995, is filed herewith. No fee is believed to be due. If, however, there are any charges or credits, please apply them to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 1/14/03

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Docket No.: 07977/108002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Divisional Patent Application of:	)	
Jun KOYAMA et al.	)	
Application No.: 09/757,778	)	Group Art Unit: 2871
Filed: January 9, 2001	)	Examiner: T. DUONG
For: ACTIVE MATRIX LIQUID CRYSTAL DISPLAY	)	
AND METHOD OF FABRICATING SAME	)	

VERIFICATION OF TRANSLATION

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

I, Noriko Inage, 116-2, Kamiohi, Ohi-machi, Ashigarakami-gun, Kanagawa-ken 258-0016 Japan, a translator, herewith declare:

that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached translation of the Japanese Patent Application No. 07-349229 filed on December 19, 1995; and

that to the best of my knowledge and belief the followings is a true and correct translation of the Japanese Patent Application No. 07-349229 filed on December 19, 1995.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 10th day of January 2003

Noriko Inage

Name: Noriko Inage

[Name of Document]	Patent Application
[Reference Number]	P003190-03
[Filing Date]	December 19, 1995
[Attention]	Commissioner, Patent Office
[International Patent Classification]	G09G 3/36 H04N 5/66
[Title of Invention]	ACTIVE MATRIX LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING SAME
[Number of Claim]	20
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[Indication of Handlings]	
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[List of Attachment]	
[Attachment]	Specification 1
[Attachment]	Drawing 1
[Attachment]	Abstract 1

[Name of Document] Specification

[Title of Invention]

ACTIVE MATRIX LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING SAME

[Scope of Claims]

[Claim 1] An active matrix liquid crystal display device comprising:

a plurality of pixel thin film transistors arranged in rows and columns on a substrate;

driver circuit thin film transistors for driving said pixel thin film transistors formed on said substrate;

a counter substrate located opposite to said substrate;

a layer of a liquid crystal material with which said pixel thin film transistors and driver circuit thin film transistors are in contact directly or via a thin film, said layer of the liquid crystal material being provided between said substrate and said counter substrate; and

a short ring mounted at an end surface of said substrate, said short ring having been cut after a rubbing operation and before a step for bonding together said substrate and said counter substrate.

[Claim 2] The display of claim 1, wherein a control circuit for controlling said driver circuit made up of said thin film transistors is packed on said substrate, and wherein said control circuit is sealed in a sealant material of said liquid crystal material placed on said substrate.

[Claim 3] The display of claim 1, wherein in order to install said control circuit, said control circuit accommodation portion of said substrate on which thin film transistors are arranged is made thinner than other portions of said substrate.

[Claim 4] The display of claim 1, wherein in order to install said control circuit, a control circuit accommodation portion of said substrate opposed to said substrate on which said thin film transistor is formed is made thinner than other portions of substrate.

[Claim 5] The display of claim 2 through claim 4, wherein said control circuit is packed on said substrate by COG (chip-on-glass) technology.

[Claim 6] An active matrix liquid crystal display device comprising:

a plurality of pixel thin film transistors arranged in rows and columns on a substrate;

driver circuit thin film transistors for driving said pixel thin film transistors formed on said substrate;

a counter substrate located opposite to said substrate;

a layer of a liquid crystal material with which said pixel thin film transistors and driver circuit thin film transistors are in contact directly or via a thin film, said layer of the liquid crystal material being provided between said substrate and said counter substrate; and

said liquid crystal material being sealed by said sealant material between said substrate and said counter substrate; and

a short ring mounted at an end surface of said substrate, said short ring having been cut within said region of said sealant material after a rubbing operation and before a step for bonding together said substrate and said counter substrate.

[Claim 7] The display of claim 6, wherein a control circuit for controlling said driver circuit made up of said thin film transistors is mounted on said substrate, and wherein said control circuit is sealed in said sealant material placed on said substrate.

[Claim 8] The display of claim 6, wherein in order to install a control circuit for controlling said driver circuit made up of said thin film transistors in a control circuit accommodation portion of said substrate, said control circuit accommodation portion is made thinner than other portions of said substrate.

[Claim 9] The display of claim 6, wherein in order to install a control circuit for controlling said driver circuit made up of said thin film transistors in a control circuit accommodation portion of said substrate, said counter substrate has a thinned portion located opposite to said control circuit accommodation portion.

[Claim 10] The display of claim 7 through claim 9, wherein said control circuit is packed on said substrate by COG (chip-on-glass) technology.

[Claim 11] A method of fabricating an active matrix liquid crystal display device having a plurality of pixel thin film transistors arranged in rows and columns on a substrate, driver circuit thin film transistors for driving said pixel thin film transistors formed on said substrate, a counter substrate located opposite to said substrate, and a layer of a liquid crystal material with which said pixel thin film transistors and driver circuit thin film transistors are in contact directly or via a thin film, said layer of the liquid crystal material being provided between said substrate and said counter substrate, and

a short ring mounted at an end surface of said substrate, said short ring having been cut within said region of said sealant material after a rubbing operation and before a step for bonding together said substrate and said counter substrate.

[Claim 12] The method of claim 11, further comprising the step of sealing a control

circuit for controlling said driver circuit made up of said thin film transistors in a sealant material of said liquid crystal material, said sealant material being positioned on said substrate.

[Claim 13] The method of claim 11, further comprising the step of thinning said control circuit accommodation portion of said substrate in order to install a control circuit for controlling said driver circuit made up of said thin film transistors.

[Claim 14] The method of claim 11, further comprising the step of thinning a portion of said counter substrate located opposite to a control circuit accommodation portion of said substrate in order to install a control circuit for controlling said driver circuit made up of said thin film transistors.

[Claim 15] The method of claims 12 thorough 14, further comprising a step of installing said control circuit on said substrate by COG (chip-on-glass) technology.

[Claim 16] A method of fabricating an active matrix liquid crystal display device having a plurality of pixel thin film transistors arranged in rows and columns on a substrate, driver circuit thin film transistors for driving said pixel thin film transistors formed on said substrate, a counter substrate located opposite to said substrate, and a layer of a liquid crystal material with which said pixel thin film transistors and driver circuit thin film transistors are in contact directly or via a thin film, said layer of the liquid crystal material being provided between said substrate and said counter substrate, said method comprising the steps of:

placing a sealant material for sealing said liquid crystal material in a region on said substrate;

performing a rubbing operation;

cutting a short ring within said region of said sealant material at an end surface of said substrate after said rubbing operation; and

then bonding together said substrate and said counter substrate.

[Claim 17] The method of claim 16, further comprising the step of sealing a control circuit for controlling said driver circuit made up of said thin film transistors in said sealant material that seals said liquid crystal material, said sealant material being positioned on said substrate.

[Claim 18] The method of claim 16, further comprising the step of thinning a control circuit accommodation portion of said substrate in order to install a control circuit for controlling said driver circuit made up of said thin film transistors.

[Claim 19] The method of claim 16, further comprising the step of thinning a portion of

said counter substrate located opposite to a control circuit accommodation portion of said substrate, in order to install a control circuit for controlling said driver circuit.

[Claim 20] The method of claims 17 thorough 19, further comprising a step of installing said control circuit on said substrate by COG (chip-on-glass) technology.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Pertains]

The present invention relates to an active matrix liquid crystal display device and, more particularly, to a miniaturized active matrix liquid crystal display device having high reliability.

[0002]

[Related Art]

An active matrix liquid crystal display device uses a liquid crystal as a display medium. A pixel is disposed at each intersection in a matrix construction. Every pixel is equipped with a switching element. Information about the pixels is represented by turning on and off the switching elements. Three-terminal elements which are thin-film transistors having gate, source, and drain are most often used as the switching elements. The thin-film transistors are hereinafter often abbreviated as TFTs.

[0003]

In the matrix construction, scanning lines (gate lines) extending parallel to a row are connected with the gate electrodes of the thin film transistor in this row. Signal lines (source lines) running parallel to a column are connected with the source (or drain) electrodes of the TFTs in this column. A scanning line driver circuit for driving the scanning lines and a signal line driver circuit for driving the signal lines are also provided.

[0004]

Fig. 2 shows a first conventional example of an active matrix liquid crystal display device. As shown in Fig. 2, a signal line driver circuit for driving signal lines is mounted above the pixel matrix of the active matrix liquid crystal display device. A scanning line driver circuit for driving scanning lines is disposed to the left.

[0005]

Fig. 3 is a cross sectional view of Fig. 2. As shown in Fig. 3, pixel TFTs are covered by a liquid crystal material. The liquid crystal material is held between a TFT substrate and a counter substrate. On the other hand, the signal line driver circuit and the scanning lien driver circuit are protected only by a thin film of oxide or nitride.

Therefore, TFTs forming these driver circuits are placed in a harsher environment than the pixel TFTs located inside the liquid crystal material.

[0006]

In an attempt to solve the foregoing problems and to obtain long-term reliability, a display device structure having improved reliability has been devised. In this structure, both a signal line driver circuit and a scanning line driver circuit are placed within a liquid crystal material, as well as pixel TFTs.

[0007]

Fig. 4 shows a second conventional example that the above-mentioned countermeasures are carried out.

In the second conventional example, a region of a sealant material such as a sealing material is located outside both a signal line driver circuit and a scanning line driver circuit. Therefore, the driver circuit TFTs are covered by the liquid crystal material, as well as the pixel TFTs. Furthermore, to miniaturize the liquid crystal display device, three end surfaces, in Fig. 4, the top end surface, bottom end surface, and right end surface of the counter substrate are made to conform to three end surfaces of the TFT substrate.

[0008]

[Problem to be Solved by the Invention]

These two conventional structures suffer from the following problems.

As shown in Fig. 5, in the conventional active matrix liquid crystal display device, a short ring is formed around the pixel matrix to prevent the destruction of TFT elements from static charges. Since the signal lines and scanning lines connected with pixel TFTs are all shorted, static charges produced during steps manufacturing the liquid crystal display device, especially during rubbing steps, for the liquid crystal display are prevented from being applied across the terminals of each pixel TFT.

[0009]

In the first-mentioned conventional structure shown in Figs. 2 and 3, it is common practice to cut the short ring together with the glass substrate with a laser beam or the like in the final manufacturing step for the liquid crystal display device.

[0010]

However, in the second-mentioned conventional structure, in an attempt to minimize the size of the liquid crystal display device, the counter substrate and the TFT substrate are preferably cut along common planes (in Fig. 4, the top end surface, bottom end surface, and right end surface of each substrate) from which no terminals are brought

out. Accordingly, it is difficult to cut the short ring with a laser beam in the final step. That is, the short ring is cut together with the substrate along a common plane. As shown in Fig. 6, after the cutting, the end surface of the substrate is exposed. If static charges are produced on the exposed end surfaces after the cutting, the internal pixel TFTs will be destroyed, thus making the display device defective.

[0011]

[Means for Solving the Problem]

A method of fabricating an active matrix liquid crystal display device according to the present invention comprises the steps described hereinafter to solve the foregoing problem.

[0012]

[Embodiment Mode of the Invention]

Fig. 1(E) shows a specific structure of an active matrix liquid crystal display device obtained by the above-mentioned constructions. In Fig. 1(E), a plurality of pixel TFTs is arranged in rows and columns on a TFT substrate. Driver circuit thin film transistors for driving the pixel TFTs are also formed on the TFT substrate. A liquid crystal material is sealed between a counter substrate and the TFT substrate by a sealant material. Since the driver circuit TFTs are present inside the liquid crystal material along with the pixel TFTs, the driver circuit TFTs can be protected. A bus line connected with the pixel TFTs is severed from a short ring to prevent the destruction of the pixel TFTs from static charges.

[0013]

In the present invention, as shown in Fig. 1(B), the step for cutting the short ring is carried out after a rubbing step in which static charges are induced. Therefore, during this step, the pixel TFTs can be protected from the static charges. Furthermore, the step for cutting the short ring is performed prior to a step for bonding together the counter substrate and the TFT substrate. Consequently, it is easy to cut the short ring.

[0014]

[Embodiments]

A method of fabricating liquid crystal display devices using active matrix circuits according to the invention will hereinafter be described in its illustrated embodiments 1 and 2.

[0015]

[Embodiment 1]

Manufacturing steps for obtaining a monolithic active matrix circuit of the present

embodiment are now described by referring to Figs. 7(A) to 7(D). These are low-temperature polysilicon processes. The left half of each figure illustrates steps for fabricating TFTs forming a driver circuit. The right half illustrates steps for fabricating TFTs forming an active matrix circuit.

[0016]

As shown in Fig. 7(A), a silicon oxide film is first formed as a base oxide film (702) on a glass substrate (701) to a thickness of 1000 to 3000 Å. This silicon oxide film may be formed in an oxygen atmosphere by sputtering or plasma CVD. Then, an amorphous silicon film is formed to a thickness of 300 to 1500 Å, preferably 500 to 1000 Å, by plasma CVD or LPCVD.

[0017]

The amorphous silicon film is thermally annealed at a temperature higher than 500 °C, preferably 500 to 600 °C, to crystallize the film or to enhance its crystallinity. After this crystallization, the crystallinity may be further enhanced by carrying out photo-annealing (making use of laser light or the like). Furthermore, during the crystallization making use of the thermal annealing, an element (or, a catalytic element) such as nickel for promoting crystallization of silicon may be added, as described in Japanese Patent Application Laid-open No. Hei 6-244103 and Japanese Patent Application Laid-open No. Hei 6-244104.

[0018]

Then, the crystallized silicon film is etched in an island shape, thereby forming an active layer (703) of a TFT of a deriver circuit (for P-channel TFTs), an active layer (704) (for N-channel TFTs), and an active layer (705) of a TFT of a matrix circuit (for pixel TFTs), respectively. Furthermore, a gate-insulating film (706) of silicon oxide is formed to a thickness of 500 to 2000 Å by sputtering in an oxygen atmosphere. The gate-insulating film (706) may be formed by plasma CVD. Where the silicon oxide film is formed by plasma CVD, it is desired to use monosilane (SiH_4) and oxygen (O_2) or dinitrogen monoxide (N_2O) as a gaseous raw material.

[0019]

Subsequently, an aluminum layer having a thickness of 2000 to 6000 Å is formed by sputtering over the whole surface of the substrate. The aluminum film is etched to form gate electrodes (707, 708, and 709). The aluminum may contain silicon, scandium, palladium, or other material to prevent generation of hillocks in thermal processing steps conducted later. (Fig. 7(A))

[0020]

Thereafter, the gate electrodes (707, 708, and 709) consisting of aluminum is anodized. As a result, surfaces of the gate electrodes (707, 708, 709) are changed into aluminum oxide (710, 711, and 712). These aluminum oxide regions act as an insulator. (Fig. 7(B))

[0021]

Then, a photoresist mask 713 covering the active layer (703) of the P-channel TFTs is formed. Phosphorus ions are introduced into the active layer (704 and 705) by ion doping while using phosphine as a dopant gas. The dose is 1×10^{12} to 5×10^{13} atoms/cm^2. As a result, heavily doped N-type regions (source and drain) (714 and 715) are formed in the active layer (704 and 705) (Fig. 7(C)).

[0022]

Thereafter, a photoresist mask (716) for covering both active layer (704) for the N-channel TFTs and active layer (705) for the pixel TFTs is formed. Boron ions are introduced again into the active layer (703) by ion doping, using diborane (B_2H_6) as a dopant gas. The dose is 5×10^{14} to 8×10^{15} atoms/cm^2. As a result, heavily doped P-type regions (717) are formed in the active layer (703). Because of the doping steps described thus far, heavily doped N-type regions (source and drain) (714 and 715) and heavily doped P-type regions (source and drain) (717) are formed (Fig. 7 (D)).

[0023]

Then, the laminate is thermally annealed at 450 to 850 °C for 0.5 to 3 hours to activate the dopants and to repair the damage created by the doping. In this way, the dopants are activated. At the same time, the crystallinity of the silicon is recovered.

[0024]

Thereafter, as shown in Fig. 8(A), a silicon oxide film having a thickness of 3000 to 6000 Å is formed as an interlayer dielectric (718) over the whole surface by plasma CVD. This interlayer dielectric (718) may be a monolayer of silicon nitride or a multilayer film of silicon oxide and silicon nitride. The interlayer dielectric (718) is etched by a wet etching process or a dry etching process to form contact holes in the source/drain regions.

[0025]

Then, an aluminum film or a multilayer film of titanium and aluminum is formed to a thickness of 2000 to 6000 Å by sputtering techniques. This film is etched so as to create electrodes/wirings (719, 720, and 721) for a peripheral circuit and electrodes/wirings (722 and 723) for pixel TFTs (Fig. 8(A)).

[0026]

Subsequently, a silicon nitride film (724) is formed as a passivation film having a thickness of 1000 to 3000 Å by plasma CVD. This silicon nitride film is etched to form contact holes extending to the electrodes (723) of the pixel TFTs. An ITO (indium-tin oxide) film having a thickness of 500 to 1500 Å is formed by sputtering. Finally, the ITO film is etched to form pixel electrodes (725). In this manner, the peripheral driver circuit and active matrix circuit are formed integrally (Fig. 8(B)).

[0027]

Steps for assembling the active matrix liquid crystal display device are now described by referring to Figs. 1(A) to 1(E). The TFT substrate and the counter substrate are cleaned to clean up chemicals etc.

[0028]

Then, an orientation film is made to adhere to each of the TFT substrate and counter substrate. The orientation film is provided with grooves lying in a predetermined direction. Liquid crystal molecules are oriented uniformly along the grooves. The orientation film material is created by preparing a solvent such as butyl Cellosolve or n-methyl-pyrrolidone and dissolving about 10% by weight of polyimide in the solvent. This is referred to as polyimide varnish and printed with a flexo-printing machine.

[0029]

The orientation films adhering to the TFT substrate and the counter substrate, respectively, are heated to cure them. This is known as baking. For this purpose, hot air having a maximum temperature of approximately 300 °C is blown against the orientation films to heat them. As a result, the polyimide varnish is sintered and cured.

[0030]

Then, a rubbing step is carried out, as shown in Fig. 1(A). Each glass substrate having the orientation film adhering thereto is rubbed in a given direction with buff cloth (consisting of fibers of rayon, nylon, or the like) having fiber lengths of 2 to 3 mm to form minute grooves.

[0031]

Then, as shown in Fig. 1(B), a short ring connected with the bus line on the TFT substrate is cut with a laser beam. In the present embodiment, a YAG laser is employed. The irradiation intensity is set to 1 x 10^{17} /cm^2 per pulse. This value is sufficient to cut the bus line.

[0032]

Spherical spacers of a polymer-based, glass-based, or silica-based material are sprayed either at the TFT substrate or at the counter substrate. The method of spraying the spacers can be a wet process in which spacers are mixed into a solvent such as pure water or alcohol and the solvent is sprayed onto the glass substrate. The method can also be a dry process in which spacers are sprayed without using solvent at all. An increase in the substrate area can be prevented by cutting the short ring at locations where the sealant materials are positioned.

[0033]

Thereafter, as shown in Fig. 1(C), the sealant material is applied to the outer frame of the pixel region of the TFT substrate, in order to bond together the TFT substrate and the counter substrate and to prevent the injected liquid crystal material from flowing out. The used sealant material is prepared by dissolving epoxy resin and a phenolic curing agent in a solvent of ethyl Cellosolve. After the application of the sealant material, the two glass substrates are bonded together by a high-temperature pressing process at 160 °C so that the sealant material is cured in about 3 hours.

[0034]

Then, as shown in Fig. 1(D), the TFT substrate and the counter substrate are bonded together. The liquid crystal material is injected through a liquid crystal injection port, followed by sealing of the port. After the completion of the sealing, the glass substrates, or the TFT substrate and counter substrate, are cut along the common planes lying in three directions (top side, bottom side, and right side of the display device shown in Fig. 2).

[0035]

Subsequently, a nonconductive or weakly conductive resin material is applied to the cut surfaces. For example, an epoxy resin is applied. As a result of the manufacturing steps described thus far, the liquid crystal display device of the present embodiment is completed.

[0036]

[Embodiment 2]

A second embodiment of the invention is shown in Fig. 9. In this embodiment, a control circuit for controlling a driver circuit consisting of thin film transistors is located under a sealant material to reduce the packing area and to enhance the reliability. Normally, the control circuit is made of a single-crystal silicon chip and thicker than a layer of a liquid crystal material. Therefore, it is impossible to place the control circuit in the

sealant material as it is. Accordingly, in the present embodiment, the counter substrate is made thinner by an amount equal to the height of the protruding portion of the control circuit above the substrate gap, as shown in Fig. 9, to accommodate this problem.

[0037]

Instead of reducing the thickness of the counter substrate, the thickness of the TFT substrate may be reduced. Alternatively, thicknesses of both counter substrate and TFT substrate may be reduced.

[0038]

The control circuit for controlling the aforementioned driver circuit is mounted on the TFT substrate by COG (chip-on-glass) technology. This COG technology may be carried out either by a wire bonding operation in which the rear surface of the control circuit chip is bonded to the TFT substrate and electrically connected with the wirings on the TFT substrate by wire bonding, or by a face-down operation in which the chip is turned upside down and the pads on the chip are connected with the wirings on the TFT substrate by conductive paste or the like.

[0039]

The TFT substrate and the counter substrate may be partially thinned by previously mechanically grinding away or chemically etching away portions of the counter substrate of interest.

[0040]

[Effect of the Invention]

In the present invention, the driver TFTs are hermetically sealed in a liquid crystal, as well as the pixel TFTs, as described above. Therefore, the temperature resistance and the contamination resistance of the driver TFTs can be improved.

[0041]

Furthermore, the short ring is cut after the rubbing operation and before the substrate-bonding operation and so the reliability, especially the reliability against electrostatic damage, can be enhanced. Additionally, it is easy to cut the short ring.

[0042]

Moreover, in the present invention, all necessary circuits including a control circuit for a driver circuit, can be placed between a pair of substrates by partially thinning at least one of TFT substrate or/and counter substrates. Further, the active matrix liquid crystal display device can be reduced in size by sealing these circuits in a liquid crystal material. Also, the reliability can be improved.

[Brief Description of Drawings]

[Fig. 1] Figs. 1(A) to 1(E) are cross-sectional views, illustrating steps for assembling a panel of an active matrix display device of the present invention.

[Fig. 2] Fig. 2 is a schematic diagram of a first conventional active matrix liquid crystal display device.

[Fig. 3] Fig. 3 is a cross-sectional view of the first conventional active matrix liquid crystal display device.

[Fig. 4] Fig. 4 is a diagram of a second conventional active matrix liquid crystal display device.

[Fig. 5] Fig. 5 is a diagram of a short ring used in a known active matrix liquid crystal display device.

[Fig. 6] Fig. 6 is a cross-sectional view of the second conventional active matrix liquid crystal display device.

[Fig. 7] Figs. 7(A) to 7(D) are cross-sectional views of a monolithic active matrix circuit according to a first embodiment of the invention, illustrating its process sequence.

[Fig. 8] Figs. 8(A) to 8(B) are cross-sectional views of a monolithic active matrix circuit according to a first embodiment of the invention, illustrating its process sequence.

[Fig. 9] Fig. 9 is a cross-sectional view of an active matrix liquid crystal display device according to a second embodiment of the invention.

[Description of Reference Symbols]

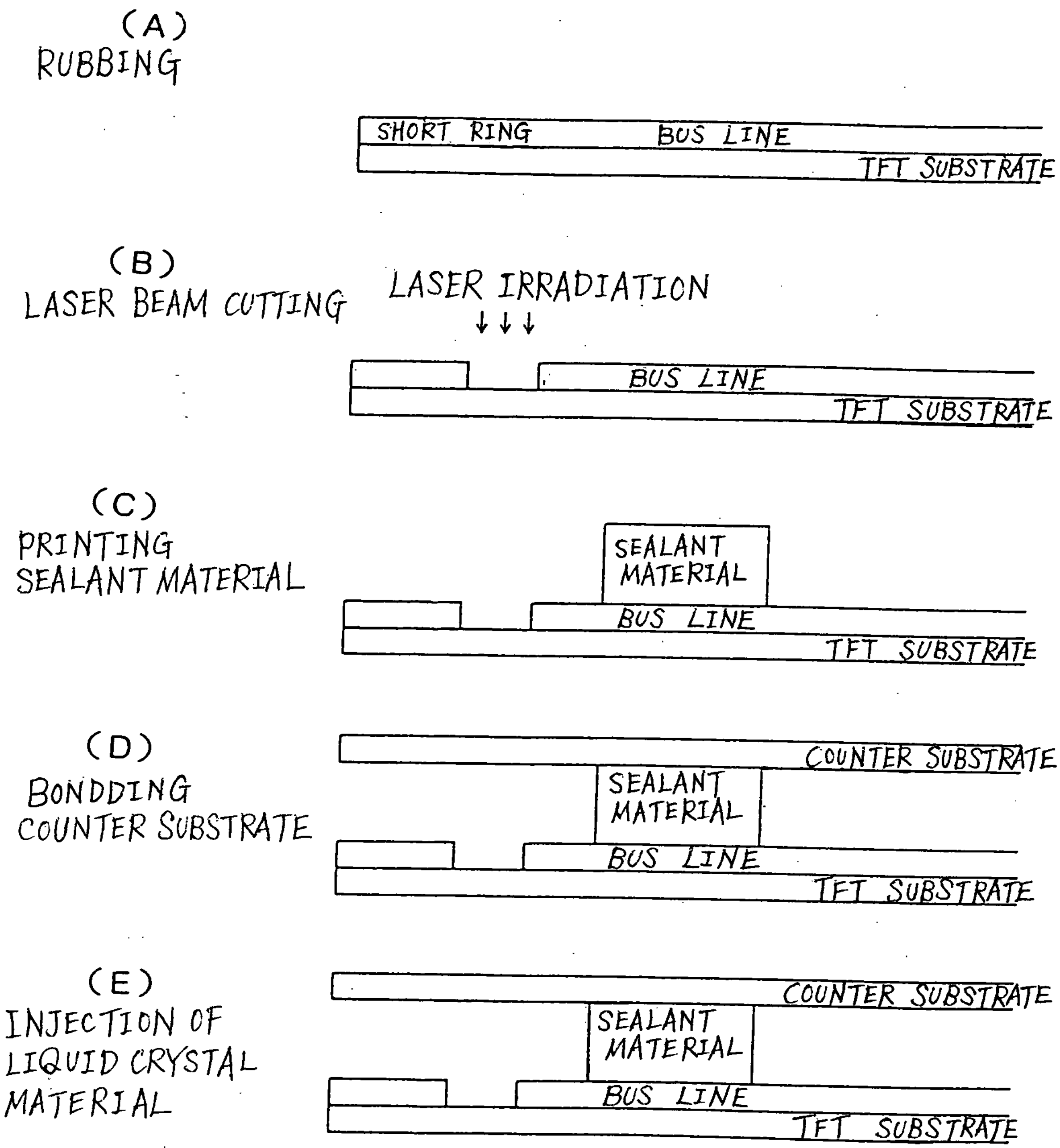
701	GLASS SUBSTRATE
702	BASE SILICON OXIDE FILM
703 to 705	SILICON ACTIVE LAYER
706	GATE-INSULATING FILM
707 to 709	GATE TERMINALS
710 to 712	ANODIZED OXIDE FILM
713, 716	PHOTORESISTS
714, 715	HEAVILY DOPED N-TYPE REGIONS (SOURCE AND DRAIN)
717	HEAVILY DOPED P-TYPE REGIONS (SOURCE AND DRAIN)
718, 724	INTERLAYER DIELECTRIC FILMS
719 to 723	Al ELECTRODES
725	PIXEL TRANSPARENT ELECTRODE

[Document Name] Abstract
[Summary]
[Problem] There is disclosed a small-sized active matrix liquid crystal display device having high reliability.
[Structure] A plurality of pixel TFTs is arranged in rows and columns on a substrate. Driver-circuit TFTs for driving the pixel TFTs are formed also on the substrate. All of these pixel TFTs and driver-circuit TFTs are covered by a liquid crystal material directly or via a thin film to protect these TFTs. A short ring is cut after a rubbing operation and before bonding of the substrates. Therefore, during manufacturing, the TFTs are protected from static charges. Also, the cutting operation is facilitated.
[Selected Drawing] Figs. 1 (A) to 1 (E)

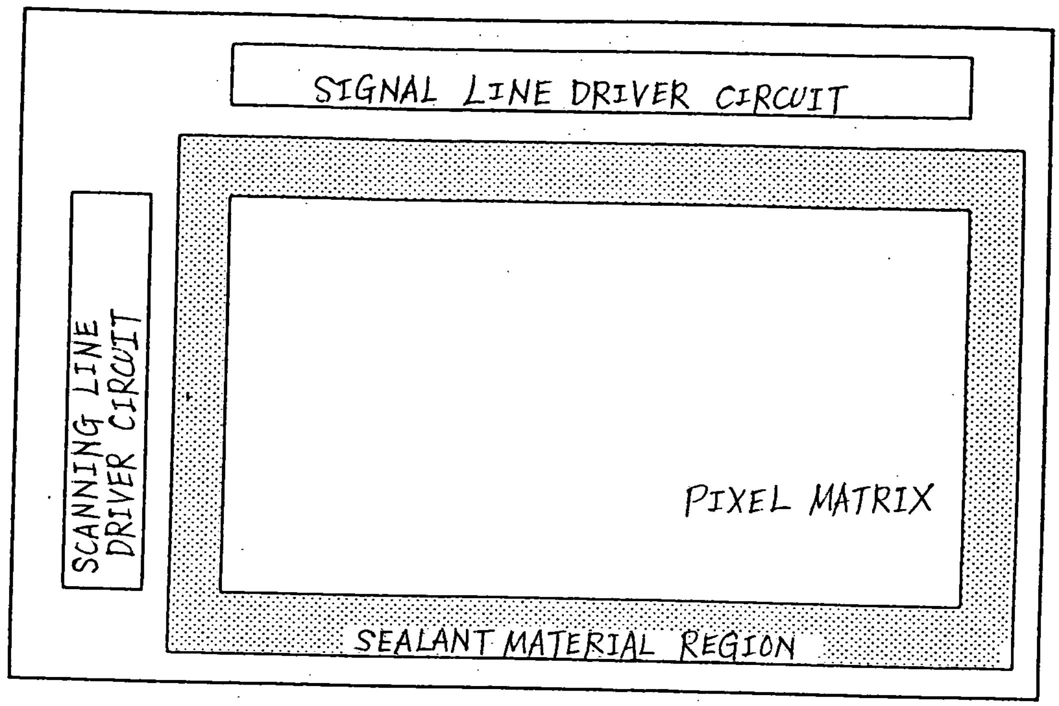
[REFERENCE No.] P003190 - 03

[DOCUMENT NAME] DRAWING

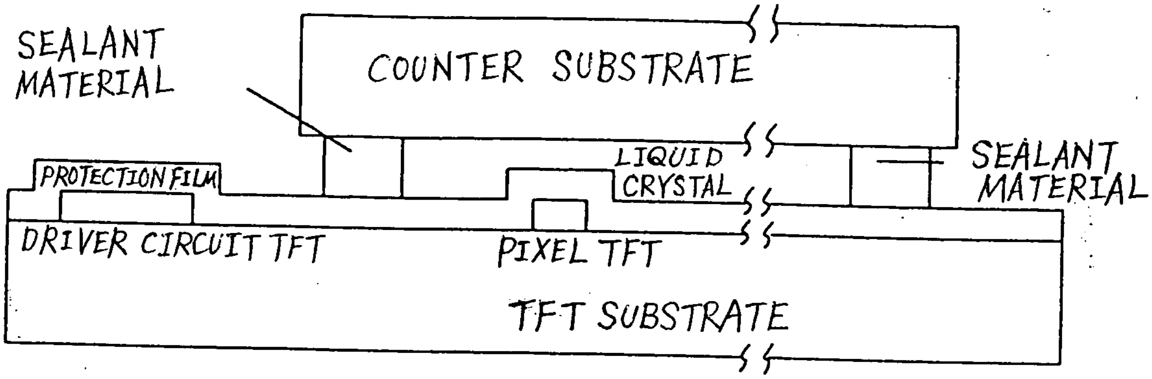
[FIG. 1]



[FIG. 2]

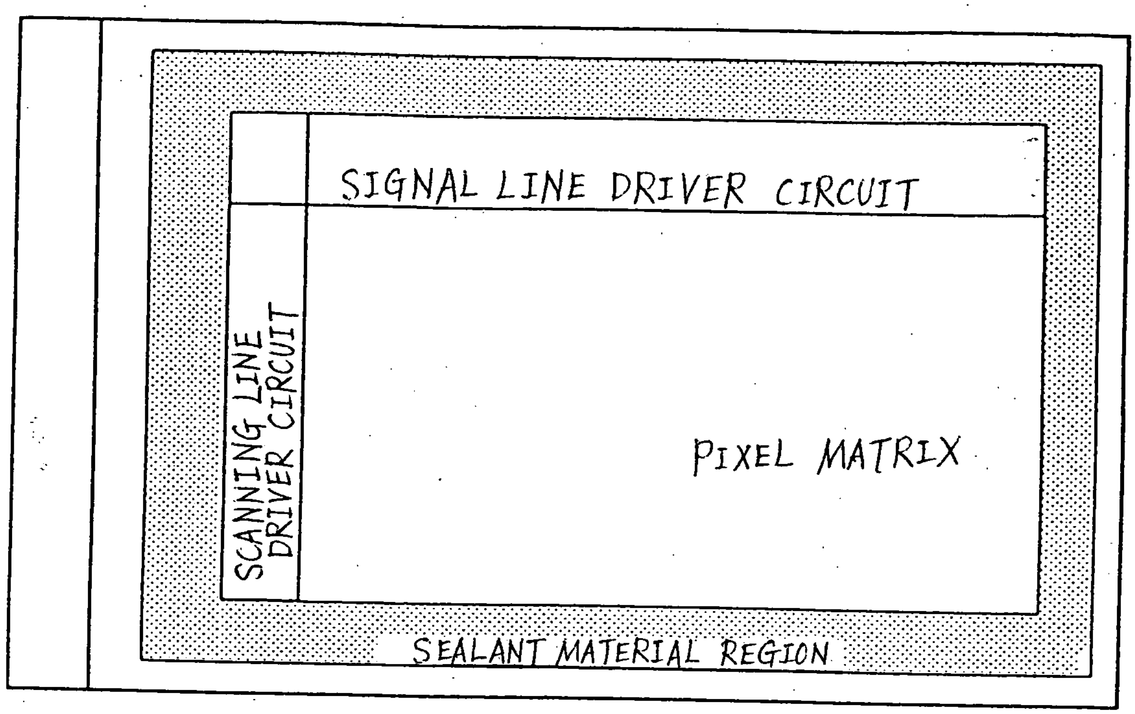

SIGNAL LINE DRIVER CIRCUIT
SCANNING LINE DRIVER CIRCUIT
PIXEL MATRIX
SEALANT MATERIAL REGION

[FIG. 3]

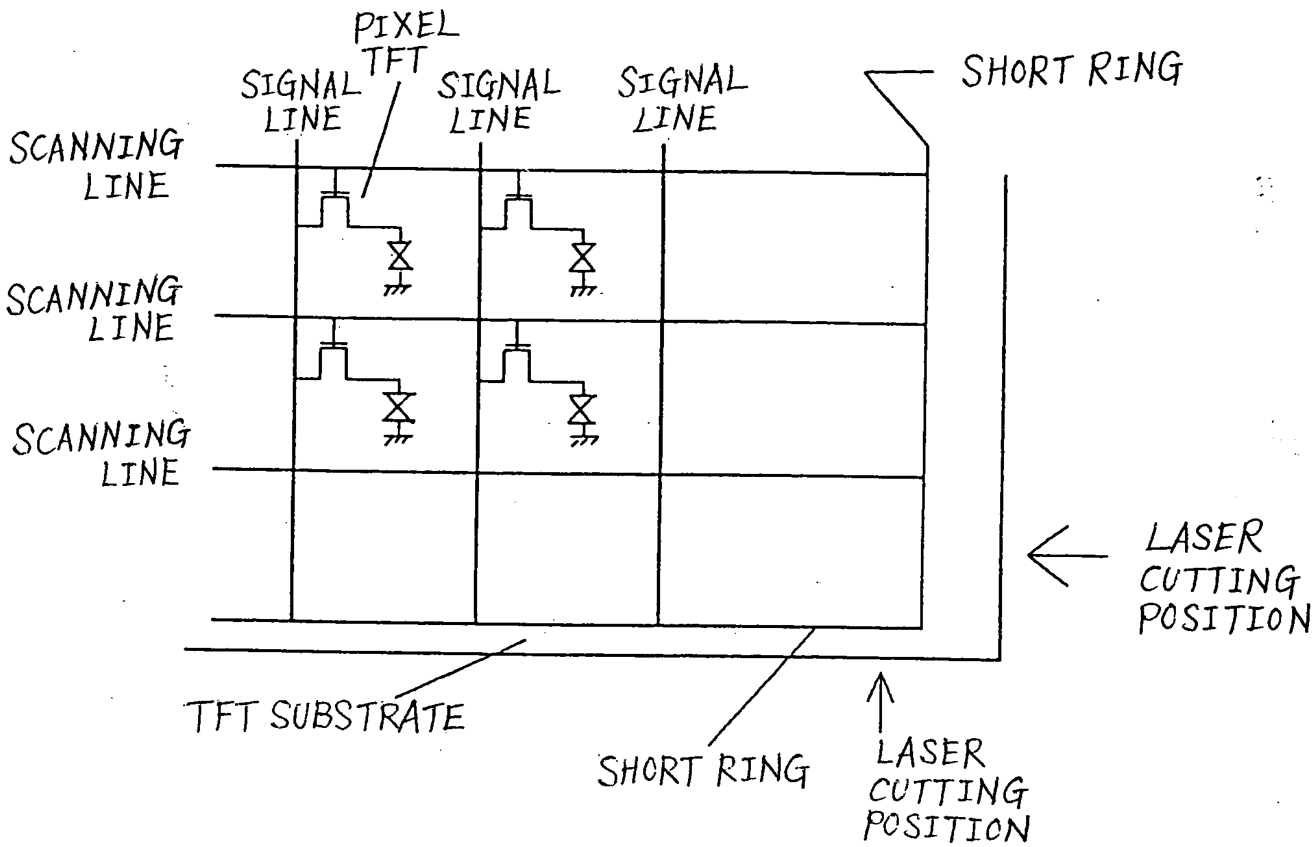

SEALANT MATERIAL
COUNTER SUBSTRATE
PROTECTION FILM
LIQUID CRYSTAL
SEALANT MATERIAL
DRIVER CIRCUIT TFT
PIXEL TFT
TFT SUBSTRATE

[REFERENCE No.] P005199 - 03

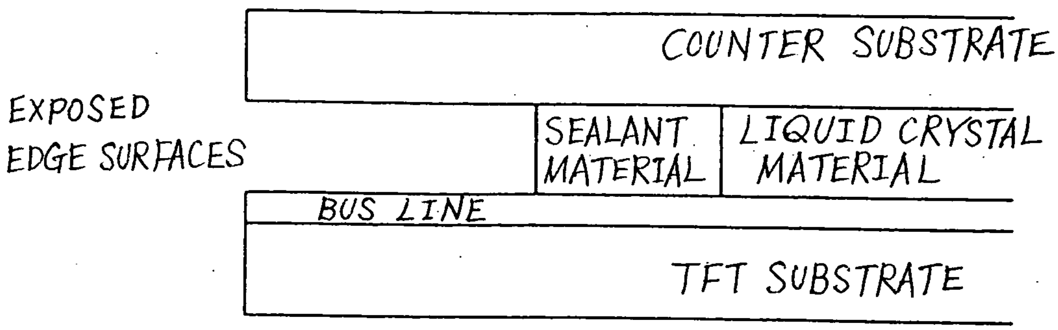
[FIG. 4]



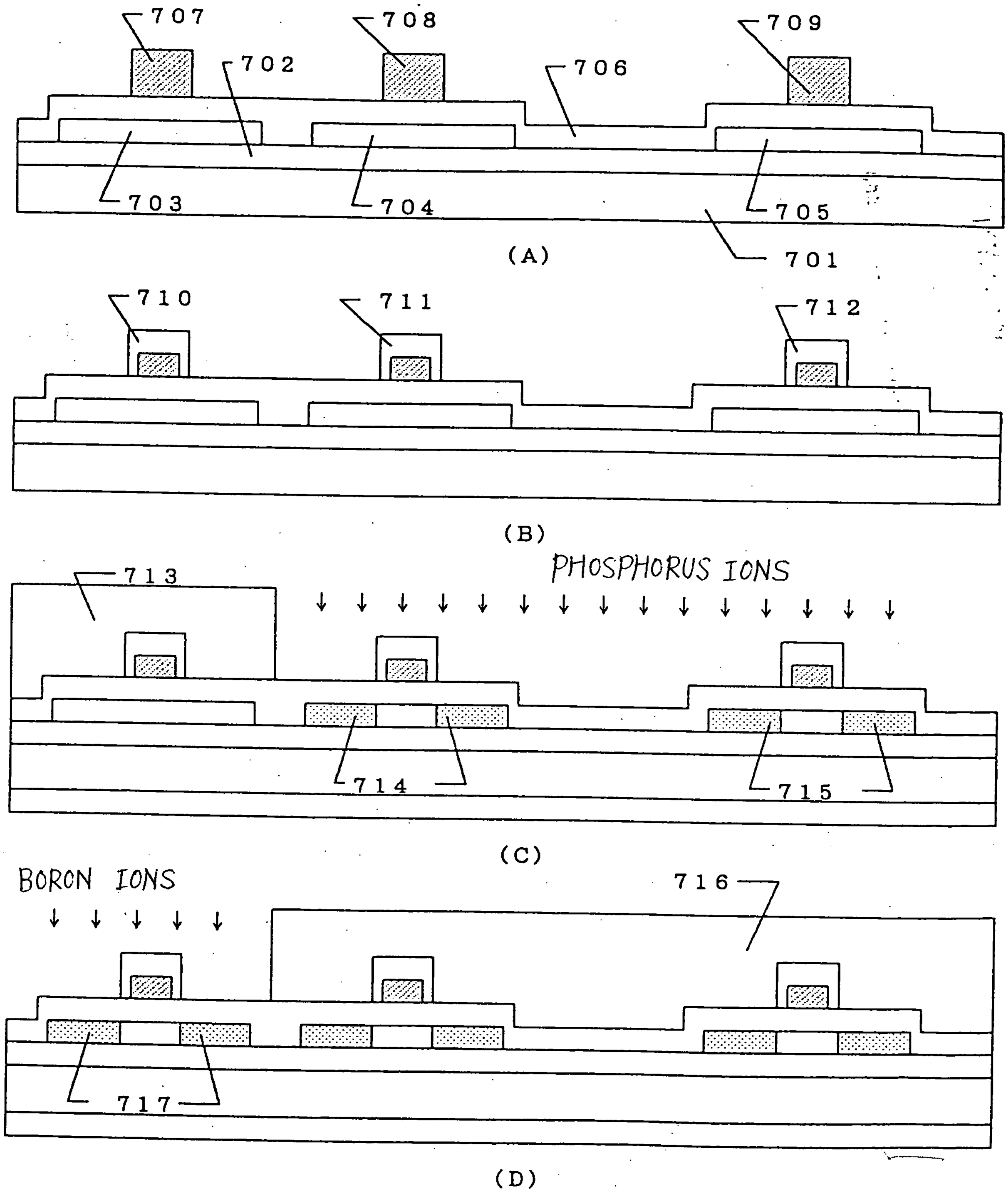
[FIG. 5]


PIXEL TFT
SIGNAL LINE
SIGNAL LINE
SIGNAL LINE
SHORT RING
SCANNING LINE
SCANNING LINE
SCANNING LINE
LASER CUTTING POSITION
TFT SUBSTRATE
SHORT RING
LASER CUTTING POSITION

[FIG. 6]


COUNTER SUBSTRATE
EXPOSED EDGE SURFACES
SEALANT MATERIAL
LIQUID CRYSTAL MATERIAL
BUS LINE
TFT SUBSTRATE

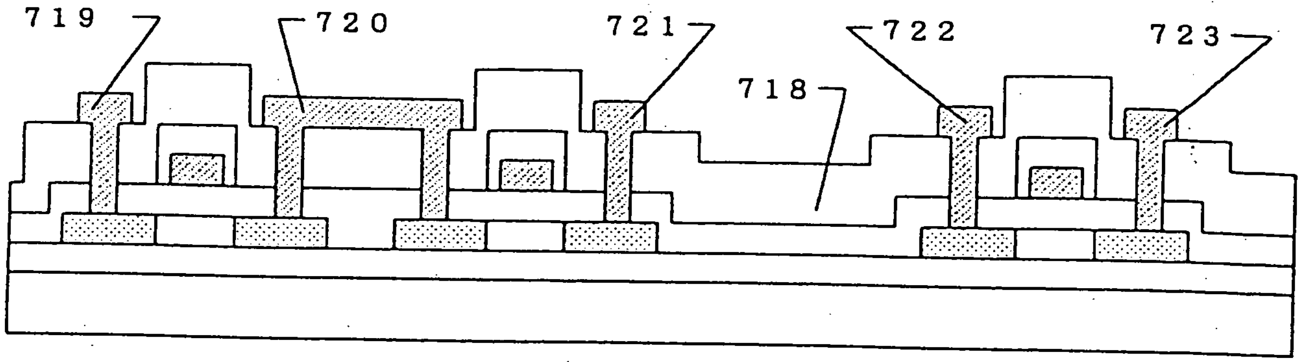
[FIG. 7]


707
708
709
702
706
703
704
705
701
(A)
710
711
712
(B)
713
PHOSPHORUS IONS
714
715
(C)
BORON IONS
716
717
(D)

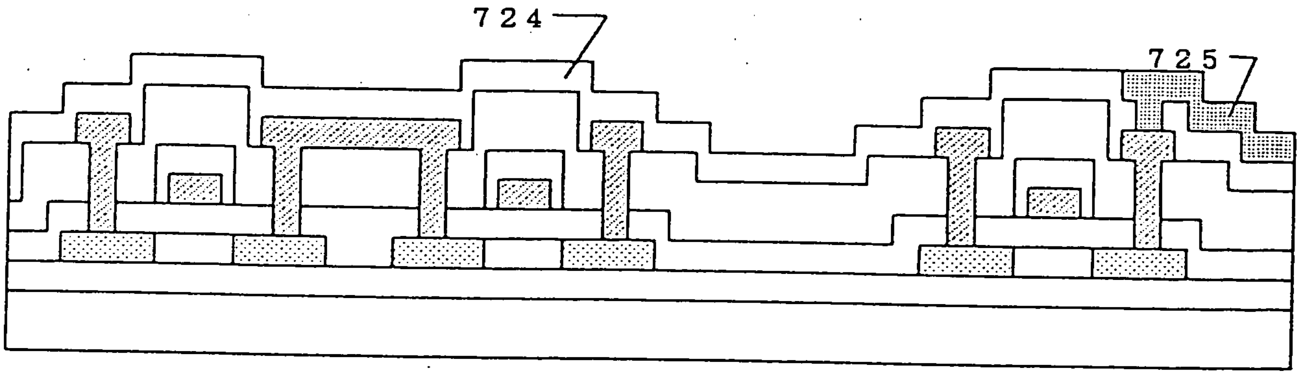
[REFERENCE No.] P005193 - 03

8

[FIG. 8]



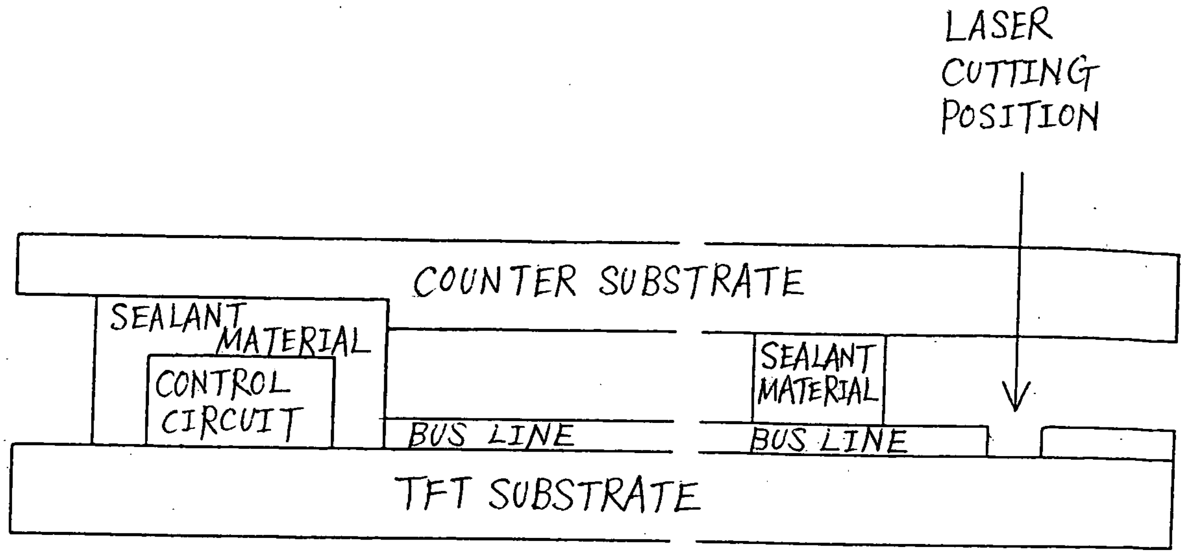
(A)



(B)

DRIVER CIRCUIT TFT ← | → PIXEL TFT

[FIG. 9]


LASER
CUTTING
POSITION
COUNTER SUBSTRATE
SEALANT MATERIAL
CONTROL CIRCUIT
SEALANT MATERIAL
BUS LINE
BUS LINE
TFT SUBSTRATE